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Relationship of Temperament Differences with Diagnosis, Severity and Accompanying Psychiatric Symptoms in Autism Spectrum Disorder

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ABSTRACT

Introduction: Temperament differences were shown in children with autism spectrum disorder (ASD); however, associations of temperament with ASD severity and accompanying psychiatric symptoms have yet to be studied.

Methods: We evaluated 58 ASD-diagnosed children's temperaments through disorder severity and psychiatric symptoms and compared them with 58 typically developed children. We utilized the Children's Behavior Questionnaire-Short Form, The Strengths and Difficulties Questionnaire (SDQ). The Childhood Autism Rating Scale (CARS) was used to evaluate psychiatric symptoms and ASD severity levels of children.

Results: Negative affect, effortful control, and perceptual sensitivity were found lower in ASD-diagnosed children and decreased with ASD severity. Effortful control was also found negatively correlated with scores of behavioral problems, hyperactivity, and total difficulties. Besides, anger/frustration was found predictive for conduct and peer problems, and total difficulty scores.

Conclusion: Further studies are needed to verify and expand these pioneer findings.

Keywords: Children, temperament, preschool, autism spectrum disorder, severity

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INTRODUCTION

Autism spectrum disorder (ASD) is a rapidly increasing neuro-developmental disorder characterized by difficulties in social communication skills, unusual repetitive behaviors, and limited interests (1). Genetic and early environmental factors play an important role in the etiology of ASD (1). Although it is not known to be etiologic or not, temperamental differences were shown in ASD-diagnosed children (2).

Temperament is defined as neurobiologically based individual differences in reactivity and self-regulation in the areas of emotion, motor activity, and attention. Although there are different theoretical approaches to temperament, the common view of all theories is that they emerge in the early stages of life, are biologically based, stable from infancy, consistent between situations, and have similar characteristics. The importance of temperament is based on the assumption that it partially shapes personality development and affects developmental outcomes (3).

The first temperament study in ASD-diagnosed children discovered that they have more challenging temperaments compared to children in the control group (4). Temperament differences have also been shown in preschool and school-age children with ASD. Compared to typically developing children, their parents have described children with ASD as less reactive and less compatible with environmental changes (5). Besides, the study utilized the Children's Behavior Questionnaire showed that ASD-diagnosed children had lower capabilities of focusing, attention shifting, inhibitory control, and soothability (2). Like the behavioral symptoms of autism spectrum disorder, it is thought that temperament also occurs during early development (6) and may help understand the emergence of ASD symptoms during follow-up. Rothbart et al. claimed that temperament could change the course of a disorder and its response to treatment, affecting the risk of the development of

Highlights

- **The relationship between temperament characteristics and disorder severity level in children with autism was investigated for the first time in this study.**
- **The results of the study showed that some characteristics related to temperament in children with autism may be related to the severity of the disorder and accompanying psychiatric symptoms.**
- **It has been shown that there may be a relationship between discomfort, inhibitory control and perceptual sensitivity and autism severity level.**
- **Angry temperament in children with autism was found to be a predictor of psychiatric symptoms.**
- **No temperament trait alone is sufficient to predict the severity of autism.**

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psychopathology (7). Therefore, examining individual-specific factors, including temperament, in the context of ASD provides the potential for early detection of emerging symptoms and selection of appropriate therapeutic interventions (8). Although many studies demonstrated ASD-diagnosed children's temperamental differences compared to neurotypical children (5, 9), no study investigated the association of child temperament with ASD severity and accompanying psychiatric problems.

Therefore, the current study's primary purpose was to investigate the associations of temperaments of ASD-diagnosed children with ASD severity and accompanying psychiatric symptoms.

Our hypotheses were:

Hypothesis 1: Temperament of children with ASD is different from controls.

Hypothesis 2: Temperament of children with ASD is associated with disorder severity.

Hypothesis 3: Temperament of children with ASD is associated with children's psychiatric symptoms.

METHOD

Participants

Children aged between three and six years with the first diagnosis of ASD and applied to the outpatient clinic of child and adolescent psychiatry at Bakırköy Psychiatric Hospital between April 2018 and December 2018 were included consecutively case group. The control group comprised children who applied to Istanbul Süleymaniye Obstetrics and Pediatrics Training and Research Hospital Pediatrics Outpatient Clinic and had typical development in the evaluation. Considering the frequency of ASD at 1% in the community and 15% in clinical samples in studies, we found that at least 58 cases and 58 controls with an alpha value of 0.05 and power of 80% would be appropriate (Kane SP. Sample Size Calculator. ClinCalc: http://clincalc.com/stats/samplesize.aspx Updated 1 July 2017. Downloaded on 22 March 2018). In line with these data, a total of 116 people, 58 cases and 58 controls, were included in the study.

The inclusion criteria of the case group were, being between the ages of 3 (36 months) and 6 (72 months) years, coming from a native Turkish speaker family, having a diagnosis of ASD based on The Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5) (10) criteria, and parental informed and signed consent to participate voluntarily to the study. Regarding the control group, similarly, children between the ages of 3 (36 months) and 6 (72 months) years and from native Turkish speaker families were included after the same informed consent process. The case group's exclusion criteria were parental intellectual disability or illiteracy, a chronic medical disease in the child, and parents' negative response to informed consent. For the controls, in addition to mentioned criteria for the cases, being on medication that could affect cognitive processes and acute or chronic mental or physical illnesses detected during the evaluation.

MATERIALS

Socio-demographic data form:

A form developed by the researchers for this study, used to evaluate the patients' socio-demographic characteristics, was filled in by the interviewer after interviewing the children's mothers.

The Children's Behavior Questionnaire – Short Form (CBQ-SF):

The Children's Behavior Questionnaire– Short Form is a 94-question scale developed by Rothbart et al. and answered by a caregiver that can be applied to children aged 3–7 (11). It allows measuring 15 temperament dimensions in a 7-point Likert-type scale. These are "activity level," "anger/frustration," "approach," "attentional focusing," "discomfort," "falling reactivity and soothability," "fear," "high-intensity pleasure," "impulsivity," "inhibitory control," "low-intensity pleasure," "perceptual sensitivity," "sadness," "shyness," "smiling and laughter." Three factors are defined in CBQ-SF, indicating three broad dimensions of temperament, including "negative affect," "extraversion," and "effortful control." The Turkish validity and reliability study was conducted by Sari et al., and the Cronbach-Alpha coefficient was found 0.78 for the whole test (12).

The Childhood Autism Rating Scale (CARS):

The Childhood Autism Rating Scale was developed by Schoppler and Reichler in 1971, and its validity and reliability studies were conducted between 1970 and 1980 (13). It was first adapted to Turkish in 1996 by Sucuoğlu et al. (14). It is a behavioral rating scale with 15 items developed to distinguish between children with intellectual disability (ID) without autism and children with autism symptoms. CARS is a useful scale in distinguishing children with autism from children with ID, also determines the clinical severity of autism as mild, moderate, and moderate-severe. It allows the half-degree scoring between 1 and 4 points for each item. The total score ranges between 15 and 60. Children whose total scores are between 15 and 29.5 points do not show autism symptoms. Children with scores between 30 and 36.5 are clinically classified as mild-moderate autism, while those whose scores are above 37 are interpreted as severe autism. CARS scoring can be done based on a clinical interview, in-class observation, information obtained from parents, and file records.

The Strengths and Difficulties Questionnaire (SDQ):

The Strengths and Difficulties Questionnaire (SDQ) is a brief behavioral screening questionnaire developed by Goodman (15). It comprises 25 items that ask about psychological symptoms of children between 2 and 17. These items are divided into five symptom domains, each comprising five items. The domains are "emotional symptoms," "conduct problems," "hyperactivity/inattention," "peer problems," and "prosocial behavior."

Each subscale can be evaluated separately via the sum of item scores. Besides, with the sum of the first four domains, the "Total Difficulty Score" can be calculated out of 20. The prosocial behavior domain's score is separately interpreted as it is a strength rather than a difficulty. Güvenir et al. conducted the validity and reliability study of SDQ for Turkish children (16). In their work, Cronbach alpha values of subscales for the parent version were found between 0.37 and 0.80, while for the total difficulties score, the Cronbach alpha coefficient was found 0.84.

Procedure

Children aged between 3 and 6 years who were admitted to our outpatient clinic with signs of developmental delay and autism were evaluated in detail by a child psychiatrist using DSM-5 diagnostic criteria for ASD, and patients meeting the criteria were included in the study. After the study's purpose and the scales were explained to the patients' families, informed consent was obtained from the volunteers. Sociodemographic data were obtained from the family using a form prepared by the researchers. The psychiatric examination and structured CARS interview of all patients in the study group were conducted by a senior specialist registrar in child psychiatry, who was also the coordinator of this thesis study, under a consultant's supervision. After diagnostic evaluation, patients' mothers were asked to respond to CBQ-SF and SDQ according to their children's findings.

Psychiatric examinations of the the control group were carried out by the same researcher. Healthy children with typical development were

included in the study. The children in the case and control group were matched based on their age and gender. Similarly, as explained above, the same inventories were applied to parents of children in the control group.

Bakırköy Psychiatric Hospital's ethics committee approved this thesis study's ethical clearance on 03.04.2018 with the decision number of 159.

Statistical Analysis

Statistical Package for the Social Sciences (IBM SPSS) version 25 (17) was used for statistical analysis. For categorical variables, values for frequency are given with percentages, and continuous variables are given as mean and standard deviation. The Chi-Square Test was used to compare categorical variables. Fisher's Exact Test was used when any of the values was five or less than five. The distribution of the continuous variables was controlled with the Kolmogorov-Smirnov test. Besides, the t-test in independent groups was utilized to compare the continuous variables with normal distribution between the groups, and the Mann-Whitney U test was carried out to compare the continuous variables without normal distribution. The correlation between continuous variables was tested using the Pearson or Spearman correlation tests according to distribution characteristics. In the current study, *p* values of statistical analyses below 0.05 were considered significant. Linear regression analyses were conducted, taking the subtests of SDQ scores (emotional, conduct problems, hyperactivity, peer problems, prosocial behaviors, total scores) and CARS score as the dependent variables and some dimensions of children's temperamental traits which were significant in correlation analyses as independent variables.

RESULTS

Sample Characteristics

Fifty-one of the patients in the case group were male (87.9%), and seven were female (12.1%). The control group patients were matched with the patients in the case group regarding age and gender. The case group's average age was 46.1 (*SD*=8.93) months, and the control group's average age was 46.1 (*SD*=8.87) months. Relevant data regarding sample characteristics are summarized in Table 1.

The Comparison of Children's Temperament Traits Between the Groups

Children's temperamental traits were explored with CBQ-SF in the study. The scores of the dimensions of disturbance, perceptual sensitivity, approach, impulsivity, sadness, focused attention, smile/laughter, and inhibitor control were found significantly lower in the cases than in the controls ($p<0.001$). No difference was observed in the other temperament dimensions ($p>0.05$). Relevant comparisons and statistical test results are given in Table 2. The temperament factors of CBQ-SF were compared between the case and control groups, and the scores of factors of negative affect, extroversion, and effortful control were found statistically significantly lower in the case group than in the control group ($p<0.001$). The distribution of the data regarding the comparisons is given in Table 2.

Relationship between temperament characteristics of children with ASD and disorder severity

When the correlation between CBQ-SF temperament trait subtest scores and CARS scores was examined, a statistically significant negative correlation was found between the discomfort ($p=0.013$), inhibitory control ($p=<0.001$), and perceptual sensitivity ($p=<0.001$) temperament

Table 1. The comparison of sample characteristics

		Cases		Controls		X^2	p
		n	%	n	%		
Gender	Girl	7	12.1	7	12.1	0.000	1.000
	Boy	51	87.9	51	87.9		
Family type	Nuclear family	49	84.5	50	86.2	0.077	0.962
	Extended	8	13.8	7	12.1		
	Divorced	1	1.7	1	1.7		
Mother's education level	Below high school	33	56.9	29	50	0.544	0.457
	High school and above	25	43.1	29	50		
Father's education level	Below high school	24	42.1	20	34.5	0.707	0.400
	High school and above	33	57.9	38	65.5		
Socio-economic status (Total income/per month)	<2000 TL (500 USD[a])	26	44.8	9	15.5	12.645	0.002**
	2000-3000 TL (500-750 USD)	13	22.4	15	25.9		
	>3000 TL (750 USD)	19	32.8	34	58.6		

	Groups							
	Cases			Controls				
	M	SD	Mdn	M	SD	Mdn	Z	p
Age (Months)	46.14	8.93	44	46.10	8.87	44	-0.030	0.976
Mother's age (Years)	33.22	5.35	33	32.17	5.00	31	-1.043	0.297
Father's age (Years)	37.02	4.85	37	36.74	5.50	37	-0.382	0.703
Sibling count	2.00	0.75	2	2.17	1.31	2	-0.120	0.905

TL, Turkish Liras; * p<0.05; ** p<0.01; n, number; %, percentage; X^2: Statistical value of the Chi-Square test; p, Significance value (2-tailed); [a] Based on Central Bank of the Republic of Turkey Exchange Rates at the time of the study.
M, Mean; SD, Standard deviation; Mdn, Median; Adm., Admission; Z, Statistical value of the Mann-Whitney U Test; p, Significance value

Table 2. The comparison of the CBQ-SF scores between the groups

	Groups							
	Cases			Controls				
	n	M	SD	n	M	SD	t	p
CBQ-SF Temperament Traits								
Activity Level	58	5.146	1.024	58	5.018	1.055	0.664	0.508
Anger/Frustration	58	4.255	1.346	58	4.543	1.219	-1.209	0.229
Discomfort	58	3.807	1.371	58	4.314	1.324	-2.029	0.045*
High-Intensity Pleasure	58	4.630	1.058	58	4.804	1.258	-0.807	0.422
Perceptual Sensitivity	58	4.559	1.393	58	6.053	1.003	-6.627	<0.001**
Approach	58	4.857	1.187	58	5.506	0.926	-3.287	0.001**
Impulsivity	58	4.034	1.352	58	4.590	1.121	-2.409	0.018*
Sadness	58	3.906	1.413	58	4.360	0.867	-2.084	0.039*
Shyness	58	3.722	1.488	58	3.818	1.577	-0.337	0.737
Attentional Focusing	58	3.284	1.132	58	4.131	1.156	-3.985	<0.001**
Fear	58	4.007	1.316	58	4.477	1.411	-1.852	0.067
Smiling and Laughter	58	4.754	1.092	58	5.262	1.108	-2.487	0.014*
Falling Reactivity and Soothability	58	4.190	1.480	58	4.655	1.362	-1.761	0.081
Low-Intensity Pleasure	58	5.285	1.123	58	5.461	1.034	-0.877	0.382
Inhibitory Control	58	3.995	1.299	58	4.871	1.106	-3.909	<0.001**
CBQ-SF Factor Dimensions								
Negative Affect	58	20.166	3.377	58	22.349	2.773	-3.805	<0.001**
Extraversion	58	22.390	2.865	58	23.737	3.071	-2.443	0.016*
Effortful Control	58	21.878	3.919	58	25.774	3.607	-5.572	<0.001**

M, Mean; SD, Standard Deviation; n, Sample Count; t, Statistical value of the Independent Samples T-test; p, Significance Value (2-tailed); CBQ-SF, The Children's Behavior Questionnaire - Short Form; * p<0.05; ** p<0.01.

trait scores and CARS scores. No significant correlation was found between the other temperament traits of the CBQ-SF and the CARS scores (p>0.05) (Table 3). Correlations between the scores of CBQ-SF factors and CARS were examined, and significant correlations were detected for the factors of negative affect (p=0.001) and effortful control (p=0<0.001). However, none of these childrens' temperamental traits were found predictive of autism severity according to linear regression analysis (Table 4).

Temperament Dimensions and Psychiatric Symptoms in Children with ASD

Correlations between CBQ-SF temperament dimension scores and SDQ symptom cluster scores were examined to reveal the relationship between temperament and psychiatric symptoms of children diagnosed with ASD in the case group. Accordingly, 11 temperament dimensions –including "anger/frustration," "attentional focusing," "falling reactivity

Table 3. Correlations between scores of CBQ-SF and SDQ subscales and CARS

	ES[a]	CP[a]	H[b]	PP[a]	PB[b]	TDS[a]	CARS Score[b]
CBQ-SF Temperament Traits							
Activity Level	0.02	0.2	0.30*	0.08	0.05	0.22	0.16
Anger/Frustration	0.53**	0.36**	0.27*	0.32*	-0.05	0.53**	-0.17
Discomfort	0.09	-0.01	0.01	-0.11	0.15	0	-0.33*
High-Intensity Pleasure	0.1	0.05	0.31*	-0.16	-0.17	0.06	-0.05
Perceptual Sensitivity	-0.06	-0.14	-0.21	0.01	0.43**	-0.13	-0.41**
Approach	-0.04	-0.08	-0.08	0.18	0.21	0.06	-0.11
Impulsivity	-0.43**	0.02	-0.04	-0.11	0.21	-0.30*	-0.04
Sadness	0.18	0.01	0.14	-0.04	0.21	0.15	-0.13
Shyness	0.40**	0.19	-0.02	-0.04	-0.21	0.17	-0.16
Attentional Focusing	-0.15	-0.12	-0.33*	-0.27*	0.34**	-0.27*	-0.14
Fear	0.09	0.03	-0.03	-0.29*	0.15	-0.06	-0.23
Smiling and Laughter	-0.21	-0.17	-0.08	-0.24	0.28*	-0.2	-0.22
Falling Reactivity and Soothability	-0.27*	-0.45**	-0.44**	-0.12	0.22	-0.48**	-0.15
Low-Intensity Pleasure	0.04	-0.33*	-0.11	0.02	0.07	-0.13	-0.19
Inhibitory Control	-0.09	-0.39**	-0.40**	-0.08	0.33*	-0.32*	-0.45**
CBQ-SF Factor Dimensions							
Negative Affect	0.23	-0.07	-0.04	-0.09	0.29*	0.03	-0.41**
Extraversion	0.03	0.07	0.09	-0.06	0.12	0	-0.11
Effortful Control	-0.13	-0.36**	-0.36**	-0.14	0.46**	-0.29*	-0.45**

N=58; *p<0.05; **p<0.01; [a] Spearman's Correlation; [b] Pearson Correlation; ES, Emotional Symptoms; CP, Conduct Problems; H, Hyperactivity; PP, Peer Problems; PB, Prosocial Behavior; TDS, Total Difficulty Score; CBQ-SF, Children's Behavior Questionnaire-Short Form; SDQ, Strengths and Difficulties Questionnaire; CARS, The Children's Autism Rating Scale.

Table 4. Linear regression analyses with scores of CBQ-SF, SDQ subscales and CARS

Dependent Variable	Predictors	Standardized coefficients β	*t*	*p*
Emotional Symptoms	Constant		1.326	0.191
	Anger/Frustration	0.385	3.289	0.002
	Impulsivity	-0.395	-3.198	0.002
	Shyness	-0.054	-0.421	0.676
	Falling Reactivity and Soothability	-0.043	-0.404	0.688
Conduct Problems	Constant		2.386	0.021
	Anger/Frustration	0.342	2.952	0.005
	Falling Reactivity and Soothability	-0.199	-1.596	0.117
	Low-Intensity Pleasure	-0.140	-0.972	0.336
	Inhibitory Control	-0.124	-0.717	0.476
	Effortful Control	-0.049	-0.255	0.800
Hyperactivity	Constant		3.772	<0.001
	Activity Level	0.103	0.892	0.377
	Anger/Frustration	0.057	0.506	0.615
	High-Intensity Pleasure	0.208	1.822	0.075
	Attentional Focusing	-0.265	-2.017	0.049
	Falling Reactivity and Soothability	-0.308	-2.596	0.012
	Inhibitory Control	-0.185	-1.041	0.303
	Effortful Control	-0.002	-0.009	0.993
Peer Problems	Constant		5.099	<0.001
	Anger/Frustration	0.389	3.227	0.002
	Attentional Focusing	-0.222	-1.862	0.068
	Fear	-0.230	-1.906	0.062
Prosocial Behavior	Constant		-1.307	0.197
	Perceptual Sensitivity	0.456	2.041	0.046
	Attentional Focusing	0.392	2.230	0.030
	Smiling and Laughter	0.312	1.678	0.100
	Inhibitory Control	0.329	1.323	0.192
	Negative Affect	0.185	1.515	0.136
	Effortful Control	-0.556	-1.209	0.232
Total Difficulty Score	Constant		4.510	<0.001
	Anger/Frustration	0.413	3.995	<0.001
	Impulsivity	-0.084	-0.826	0.413
	Attentional Focusing	-0.236	-2.066	0.044
	Falling Reactivity and Soothability	-0.236	-2.248	0.029
	Inhibitory Control	-0.155	-1.010	0.317
	Effortful Control	0.035	0.207	0.837
CARS Score	Constant		11.087	<0.001
	Discomfort	-0.029	-0.201	0.841
	Perceptual Sensitivity	-0.212	-1.159	0.252
	Inhibitory Control	-0.211	-1.163	0.250
	Negative Affect	-0.270	-1.891	0.064
	Effortful Control	-0.051	-0.212	0.833

N=58; CBQ-SF, Children's Behavior Questionnaire-Short Form; SDQ, Strengths and Difficulties Questionnaire; CARS, The Children's Autism Rating Scale

and soothability," "fear," "high-intensity pleasure," "impulsivity," "inhibitory control," "low-intensity pleasure," "perceptual sensitivity," "shyness," "smiling and laughter"– were found significantly correlated with SDQ symptom clusters (Table 3).

Among these, the most robust positive correlations (p<0.01) were found between "anger/frustration" and emotional symptoms and total difficulty score, "perceptual sensitivity" and social behavior, "shyness" and emotional symptoms. On the other hand, the strongest negative correlations (p<0.01) were found between "falling reactivity and soothability" and conduct problems, hyperactivity, and total difficulty score, "impulsivity" with emotional symptoms, "inhibitory control" with conduct problems and hyperactivity (Table 3). When the correlations between CBQ-SF factors and SDQ subscale scores were examined, a positive, statistically significant correlation was found between the scores of negative affect dimension and prosocial behavior (p=0.030). A significant negative correlation was found between the effortful control sub-dimension scores and conduct problems (p=0.005), hyperactivity

(p=0.006), and total difficulty scores (p=0.026), while with the prosocial behavior (p<0.001) score in a positive direction. The data relevant to these correlations are given in Table 3.

Linear regression analyses were conducted for significant correlations of CBQ-SF temperament dimension scores and SDQ symptom scores. As a result, for emotional symptoms anger/frustration (p<0.01) and impulsivity (p<0.01), for conduct problems anger/frustration (p<0.01), for hyperactivity falling reactivity/soothability (p=0.012), for peer problems anger/frustration (p<0.01), for prosocial behaviors perceptual sensitivity (p=0.046) and attentional focusing (p=0.03), and for total difficulty scores anger/frustration (p<0.01) and falling reactivity/soothability (p=0.029) were found predictive (Table 4).

DISCUSSION

We investigated the associations of temperaments of ASD-diagnosed children with disorder severity and comorbid psychiatric symptoms in the study. We also evaluated the temperamental differences of children with ASD compared to healthy controls. The findings of this study suggest that temperamental factors of children might affect the severity of ASD and accompanying psychiatric symptoms, in addition to their difference from typically developed peers. Relevant hypotheses of the study will be discussed in detail in sequence in light of our findings and the literature.

Hypothesis 1 suggested that temperamental traits of children with ASD would differ from their typically developed peers. Among the temperament characteristics obtained through CBQ-SF, the scores of discomfort, perceptual sensitivity, approach, impulsivity, sadness, attentional focusing, smiling/laughter, and inhibitory control were found lower in the case group than the controls. Regarding broad temperament dimensions based on CBQ-SF, children with ASD showed less negative emotions, extrovert traits, and effortful control in our study. In other words, as expected and confirming our first hypothesis, it was found that children with ASD differ from controls in most temperamental traits. Similar to our results, several studies also stated lower extrovert traits in ASD, which is indeed a core feature of the disorder (9, 18–20). Again, in studies utilized CBQ-SF to measure temperaments in children with ASD, only effortful control factor and traits of attentional focusing and inhibitory control were found decreased relative to typical children (2). It seems that effortful control might be a significant discriminating factor between children with and without ASD among temperament dimensions. Effortful control has been defined as the ability to suppress a dominant response to activate a subdominant response, or the efficiency of executive attentional abilities (such as planning, error detecting) (21, 22). As autism is one of the most severe forms of neurodevelopmental disorders, expectedly, this might deter the processes of executive functions.

In contrast to previous studies indicating higher scores for the temperament of negative affect in ASD-diagnosed children (9, 20), we found the scores of this variable lower in the case group counterintuitively. This inconsistency might be due to relatively higher severity of autism in our case group, because we detected certain difficulties when measuring emotional traits through parent reports especially in children with severe ASD.

Hypothesis 2 stated that certain temperamental dimensions would be associated with the severity of ASD. Although we found correlations of CARS scores with the temperament dimensions of negative affect, effortful control, discomfort, inhibitory control, and perceptual sensitivity, none of these traits were found predictive for ASD severity with linear regression. As we mentioned above, negative correlations for discomfort and negative emotional traits could be interpreted as severity increase in ASD would deter the evaluation of temperament, because these two sets of problems are expected to be increased in children with autism in contrast to our finding. Regarding effortful control, as we explained above, it is a temperamental dimension that addresses self-regulation skills. Accordingly, an increase in autism severity might deter the abilities of these skills. Thus, it can be interpreted that more severe symptoms of ASD may impair behavioral control more profoundly.

Regarding our result about perceptual sensitivity, it seems also reasonable, as this temperament trait is related to apprehending subtle social cues and facial expressions. Therefore, deterioration of this ability could be more profound as the severity of ASD increases. To the best of our knowledge, no studies investigated the association of temperamental traits with ASD severity, and with its pioneer feature, our findings related to disorder severity might contribute to the literature.

Consistent with Hypothesis 3, certain temperamental traits and dimensions in children with ASD were correlated with psychiatric symptom clusters of SDQ. Of broad dimensions of temperament, effortful control was found negatively correlated with scores of behavioral problems, hyperactivity, and total difficulties. This might indicate that ASD-diagnosed children with less inhibitory control are more likely to suffer from conduct problems and hyperactivity. We also found a robust positive correlation between this factor and prosocial behavior, indicating that children with ASD whose behavioral control abilities are relatively preserved might possess more socially acceptable behavioral skills and vice versa. Consistent with our result, there are studies in the literature suggesting that disrupted effortful control is associated with emotional and behavioral problems. In contrast, sound effortful control is related to social competence, empathy, and self-respect (23–25). However, in linear regression analyses, this temperament factor was not found predictive for psychiatric symptoms of children with ASD.

With regards to specific temperament traits of children with ASD, anger/frustration was found correlated with all difficulty subscales of SDQ. Also, anger/frustration was found predictive for emotional symptoms, conduct problems, peer problems, and total difficulty scores of children according to linear regression analyses. This might indicate that this temperament is strongly associated with a broad range of psychiatric comorbidities. Similar to our findings, previous studies also showed that anger is associated with internalizing and externalizing problems and low social competence (24). Besides, according to our findings, preserved attentional abilities seem to be a protective factor against hyperactivity, social and peer problems, and general difficulties, and possibly vice versa. Moreover, the temperamental feature of "falling reactivity and soothability," which indicates the ability to calm down in challenging occasions, was found potently correlated with conduct problems, hyperactivity, and total difficulties, and though relatively weakly with emotional problems. This correlation was also verified for hyperactivity and total difficulties scores with regression analyses. Furthermore, inhibitory control, which is a major capability for self-regulation, was significantly correlated negatively with conduct problems, hyperactivity, and total difficulties. It was also found associated with social abilities in a positive direction. Overall, consistent with our foresight, temperamental traits might play a role in psychiatric comorbidities in ASD-diagnosed children as both protective and predisposing factors.

Overall, the findings of this study suggest that temperament traits of ASD-diagnosed children might affect the severity of symptoms in ASD and comorbid psychiatric symptoms. Accordingly, we might imply that during the assessment of children with ASD admitted to clinics, taking into account children's temperament characteristics might help tailor unique interventions that will help alleviate symptoms and prevent and treat psychiatric comorbidities.

As a conclusion, this current study demonstrates the associations of the temperament of ASD-diagnosed children with the severity of ASD and accompanying psychiatric symptoms for the first time. The temperament dimension of effortful control seems significantly associated with ASD diagnosis and severity, and comorbid psychiatric conditions. Regarding the cluster of negative affect, although its subtraits of anger and difficult soothing were associated with accompanying psychiatric symptoms, counterintuitively the scores for the whole factor were negatively correlated with the diagnosis and severity of ASD. We interpreted this finding that negative emotions like sadness and fear might be difficult to detect in children with ASD. Besides, we discovered that perceptual sensitivity is a temperament trait that predicts the severity of autism. The findings of our study need to be confirmed and developed with further studies.

The findings of the current study should be interpreted under certain limitations. Firstly, the evaluation of child temperament through parent responded questionnaires might have given rise to certain response biases and, in turn, compromised actual results. Although we had calculated the sample size based on power analysis, a study with a larger sample size might have indicated more significant and exact results. Future studies using direct observation of children with autism with a larger sample size might expand our results. Despite limitations, its certain strengths, such as the presence of a matched control group in terms of age and gender, being a pioneer for investigating the relationship of child temperament with the severity and comorbidity of ASD, make our work worth sharing.

Ethics Committee Approval: Bakırköy Psychiatric Hospital's Ethics Committee approved this thesis study's ethical clearance on 03.04.2018 with the decision number of 159.

Informed Consent: Informed consent was obtained from the volunteers.

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